
*1997/98 ANNUAL
COMBINED SEWER OVERFLOW
REPORT*

*King County Department of Natural Resources
Wastewater Treatment Division*

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KING COUNTY
Department of Natural Resources

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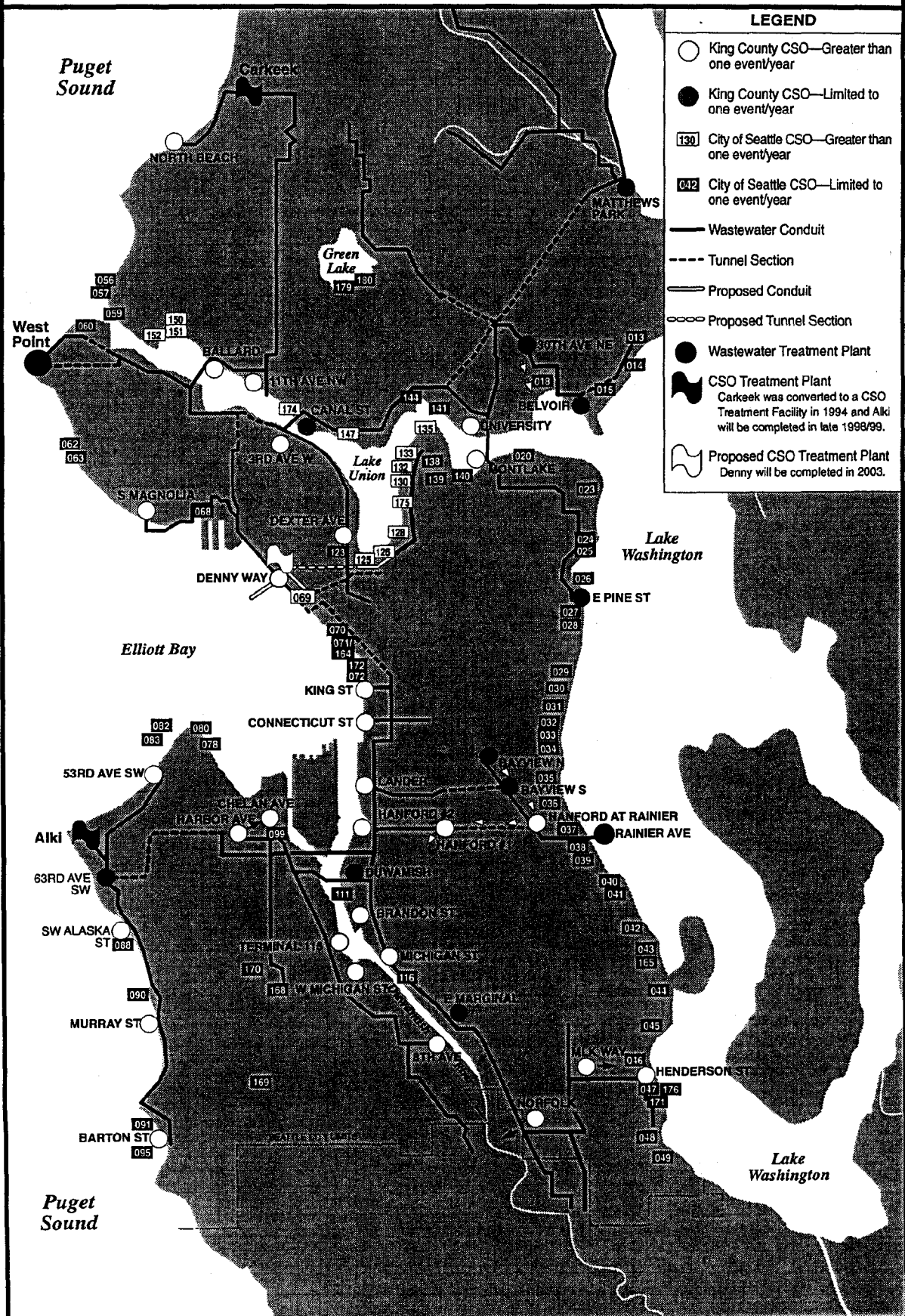
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Combined Sewer Overflow (CSO) Map



Section 1 - Overview and Status of CSO Control Program

1.1 Introduction

This report is prepared and submitted to the Department of Ecology (Ecology) in accordance with the requirements established within NPDES Permits WA-002918-1 and WA-002901-7 and WAC 173-245-090. As outlined in the WAC, this report includes:

- ◆ An overview and status of King County Department of Natural Resources, Wastewater Treatment Division's (WTD's) CSO Control Program
- ◆ 1997/98 overflow volume and frequency information
- ◆ An overview of King County WTD's CSO Monitoring Program

1.2 Background

King County WTD provides wholesale wastewater conveyance and treatment for flows from the City of Seattle and thirty-five other cities and sewer districts. The City of Seattle collection system contains combined sewers that collect both sanitary sewage and stormwater. Seattle's wastewater collection system conveys flow to County trunks and interceptors which then convey flows to the County's West Point treatment plant located off West Point in Discovery Park. When storm events occur, flows may exceed the capacity of the collection system pipes, resulting in combined sewer overflows (CSOs) into Lake Washington, Lake Union, the Ship Canal, the Duwamish River, and Elliott Bay and Puget Sound (Figure 1-1). CSOs are a recognized source of water pollution that can result in aesthetic degradation of shorelines during CSO events and impact sediment quality at discharge points. CSOs may raise public health concerns in areas where there is potential for public contact.

Since the 1960s, King County has been conducting CSO control projects to improve water quality in the Seattle-King County area. The County first formalized its CSO control program with the development of its *1979 CSO Control Program (1979 Program)*. The *1979 Program* identified nine projects to control CSO events into fresh water areas (i.e., Lake Washington, Lake Union, and the Ship Canal).

In 1985, new regulations were introduced with the Washington State Water Pollution Control Act (RCW 90.48) requiring all municipalities with CSOs to develop plans for "...the greatest reasonable reduction at the earliest possible date." The County's *1986 Plan for Secondary Treatment Facilities and Combined Sewer Overflow Control (1986 Plan)* met this state requirement.

Before the *1986 Plan* was implemented, new regulations were promulgated by Ecology. The new regulations (WAC 173-245-020) defined "greatest reasonable reduction" to mean "control of each CSO such that an average of one untreated discharge may occur per year." The County worked with Ecology to develop an interim goal of 75 percent reduction of CSO volumes systemwide by the end of 2005. The

County's *Final 1988 Combined Sewer Overflow Control Plan (1988 Plan)* identified eleven CSO control projects designed to meet this interim goal.

As part of the renewal process for the West Point treatment plant NPDES permit, King County prepared an update/amendment to the *1988 Plan*. The *1995 CSO Update* includes an assessment of the effectiveness of CSO reduction efforts to date, a re-evaluation of priority for CSO sites, and a list of projects for the next five years.

In November 1996, King County WTD renegotiated the requirement to reduce CSO discharges by 75 percent system-wide by 2005. Working with Ecology, King County WTD identified an approach that would allow control of CSOs along public access areas and bathing beaches sooner than under the previous agreement.

Regional Wastewater Services Plan

The *Metropolitan Seattle Sewerage and Drainage Survey* was prepared in 1958 to guide a long-range program of sewerage and drainage services for the Seattle area. That first comprehensive planning document was intended to provide a concise, up-to-date, central source of information concerning King County's long-range plans. Since that time, numerous amendments have been made to the original comprehensive plan.

King County WTD's CSO planning is one component of WTD's current long-range wastewater planning effort, the *Regional Wastewater Services Plan (RWSP)*. The *RWSP* will be an amendment to the *Metropolitan Seattle Sewerage and Drainage Survey* that will integrate long-range planning in all areas of wastewater services, including treatment and conveyance, biosolids management, CSO control, and water reuse. The *RWSP* planning process will establish the priorities for all wastewater programs, including those that affect CSO controls. The *Draft RWSP* was issued in May 1997. The King County Executive issued a report describing the Executive's preferred alternative in April 1998. The King County Council is expected to adopt a Final Plan and final Environmental Impact Statement (EIS) in late 1998. All CSO projects defined by the *RWSP* will be included in the year 2000 CSO Plan Update, including project descriptions and schedules for project completion.

1.3 Status of CSO Control Projects

1.3.1 CSO Control Projects from the 1988 Plan

The *1988 Plan* identified several CSO control projects that King County would undertake through late 2005 to meet the interim goal of 75 percent reduction of CSO volumes systemwide. Table 1-1 summarizes *1988 Plan* projects that have been completed. Table 1-2 summarizes projects from the *1988 Plan* that are in progress or have been modified since the *1988 Plan* was issued. Project descriptions for modified projects or projects underway are also provided.

Table 1-1. Completed Projects from the 1988 Plan

Project	Year Started	Year Completed
Hanford Separation	1986	1987
Lander Separation/Bayview Storage	1986	1992
Fort Lawton Parallel Tunnel	1987	1991
University Regulator (Densmore Diversion)	1986	1994
Carkeek Transfer/CSO Treatment Plant	1988	1994

Table 1-2. Other Projects from the 1988 Plan

Project	Year to Start	Year to be Completed
CATAD Modifications	1987	Ongoing
Alki Transfer/CSO Treatment Plant	1989	1998
Denny Way CSO Control	1993	2003 ^a
Kingdome/Industrial Area Storage and Separation	2000	RWSP ^b
Michigan Street Separation	1997	RWSP ^b
Diagonal Separation	1995	City of Seattle project

^a Delayed and modified as discussed in text. See pages 4 and 8.

^b Project modified in the RWSP.

Since the 1988 Plan, the Lander separation project include low flow diversion of stormwater into the sanitary sewer system, and source control efforts are applied to new stormwater discharges.

1.3.1.1 CATAD Modifications

The Computer Augmented Treatment and Disposal System (CATAD) controls the West Point treatment plant collection system. A new control program for the CATAD system was developed to improve system efficiency by increasing utilization of storage capacity in existing sewers. Prior to the improvements, the CATAD system utilized 17 to 28 million gallons (MG) or 28 to 47 percent of storage within the collection system's estimated 60 MG capacity. Initial estimates projected that modifications to the system would reduce CSO volumes by 150 MG per year. Computer simulations indicate that the overflow reduction achieved by these improvements may total 200 MG per year. The project is mostly complete, although calibration work on level sensors is continuing. Modifications are needed to incorporate new flow transfer projects and to improve the efficiency and robustness of the optimization program.

1.3.1.2 Alki Transfer/CSO Treatment Plant

Design for the Alki project began in 1989 and construction will be completed in 1998. Flow transfer will occur by 1999. Specific permit conditions for operation of the Alki facility will be negotiated with Ecology.

The Alki project is designed to transfer flows up to 18.9 mgd from the Alki drainage basin to the West Point treatment plant for secondary treatment. Combined sewer flows above 18.9 mgd, up to a maximum of 50 mgd will receive primary treatment and disinfection at a modified Alki plant with discharge through the existing outfall. The modifications at the Alki plant will allow for intermittent treatment. In order to protect the treatment facility, flows in excess of 65 mgd (estimated to occur, on average, about once per year) will be discharged via the 63rd Avenue pump station outfall, which is a permitted CSO location.

A new tunnel and West Seattle pump station provides conveyance of Alki flows to the Elliott Bay Interceptor (EBI) and West Point treatment plant. To avoid exacerbating CSOs in the West Division treatment plant system due to the addition of Alki flows, pipelines were constructed in 1995-96 to transfer at least 18.9 mgd from the southern part of the West Point treatment plant service area to the East Section Reclamation Plant at Renton via the Allentown trunk and Interurban pump station.

A pipeline to convey Harbor regulator station CSO's to the new West Seattle tunnel for storage and control to one event per year was added to this project and will function as designed after the Alki CSO treatment facility comes on line as discussed later in this report (see Section 1.3.2.2).

1.3.1.3 Denny Way CSO Control Project

The 1986 Plan identified a storage and treatment approach to controlling Denny Way overflows. In the 1988 Plan, the Denny Way project was changed to include partial separation of 584 acres in the Denny/Lake Union and Denny Local drainage basins. Predesign for the project was scheduled to begin in 1993 with construction ending in 1999.

In late 1991, the Seattle Public Utilities (formerly Seattle Drainage and Wastewater Utility) requested that King County participate in a joint analysis of CSO alternatives to control discharges into Lake Union from Seattle's system and into Elliott Bay from the County's system at the Denny Way regulator station. In 1992, a joint Denny Way/Lake Union CSO Control Project was submitted as a candidate for Federal Infrastructure Grant funds. During 1994, a specific joint City of Seattle/King County, Denny Way/Lake Union CSO Control project was developed, and a \$35 million Infrastructure Grant was awarded by the Environmental Protection Agency. This joint project is discussed later in this report. It is in design and expected to be complete in 2004. (see Section 1.3.2.1).

1.3.1.4 Kingdome/Industrial Area Storage and Separation Project

Under the 1988 Plan, the Kingdome/Industrial Basin was identified as an area for partial separation of CSOs scheduled to be completed by the year 2006.

The Kingdome Separation Predesign report was completed in October 1991. The predesign report studied five different levels of sewer separation. Each separation level required an associated storage component to achieve the goal of one event per year.

The recommended alternative was to construct the Level 2 separation (128.5 acres) and a 11.2 MG storage tank. The total cost of the alternative was \$25.7 million (1991 dollars).

Because the one per year CSO improvements were not needed until the year 2006, the report recommended deferring the storage tank until after the year 2000. The near term recommendation was to construct the Level 1 separation and 3,050 linear feet (lf) of 96-inch trunk, (extending from Alaskan way to Airport Way) prior to road widening.

In 1993-94, the County constructed approximately half of the 96-inch trunk line (1500 lf), extending from Alaskan Way to Third Avenue South. No actual separation work was done at that time, although laterals were placed so separation could occur at a later date. The 96-inch pipe has since functioned as a storage tank and is estimated to reduce CSOs by 12 MG per year.

In November 1995, the Washington State Legislature authorized funding for construction of a new professional baseball stadium. The Washington State Major League Baseball Stadium Public Facilities District (PFD) was formed to administer the project. Design of the project began in early 1996. King County staff began working closely with the PFD's engineers to resolve significant utilities issues created by the location of the stadium directly over the EBI.

The PFD will complete 60% of the Level 1 separation between Alaskan Way and Third Avenue South. The PFD will construct the necessary diversion and overflow structures to allow an existing 72-inch combined sewer pipeline to be converted to a separate storm sewer from Third Avenue to Elliott Bay. The idea has been approved, and the PFD is proceeding with construction. Startup of the system is scheduled for October 1998.

Construction of the new baseball stadium has sparked major new development in the Kingdome / Industrial basin. In addition to the baseball stadium, a new football stadium is proposed north of Royal Brougham, and the Washington Department of Transportation (DOT) is proposing new freeway access ramps on Royal Brougham and Atlantic Streets. The spur in new construction is an impetus to again look at the Kingdome Separation Project to see if additional opportunities for separation exist. Current plans are for both the football stadium and DOT projects to discharge into the separated system.

With the Kingdome separation work already initiated by PFD and DOT, the County is in a good position to achieve 78 acres of the original 128.5 proposed for Level 1 separation, as laid out in the 1991 report.

1.3.1.5 Michigan Street Separation Project

The Michigan project, as described in the *1988 Plan*, included total separation in the Michigan basin. The project was scheduled for completion by the end of 2005. The predesign effort for the Michigan project was accelerated to 1992 in conjunction with work being undertaken by the DOT to upgrade the First Avenue South bridge. The predesign report showed that DOT upgrade of the First Avenue South bridge would not impact the Michigan Street CSO project.

Recent County analysis for the *RWSP* indicates that CSO control at Michigan would be best achieved via on-site CSO treatment. The schedule for implementation of a Michigan project is 2022 in the Executive Preferred Plan issued in April 1998. This could change pending council approval.

1.3.1.6 Diagonal Separation Project

In the *1988 Plan*, the Diagonal storage/separation project was identified as a City of Seattle project and not as a County project. The Diagonal project would provide total separation of sanitary and storm drainage by installing new sewers in about 720 acres of combined or partially-separated industrial area. The project would compliment the City of Seattle's project that separated areas adjacent to the County's Duwamish pump station.

1.3.2 1995 CSO Update Projects

Since the *1988 Plan*, four new projects for CSO control have emerged primarily as a result of more accurate modeling information. The projects are discussed in the *1995 CSO Update* and are as follows:

- ◆ Harbor CSO Pipeline Project
- ◆ Henderson/Martin Luther King Jr. Way CSO Control Project
- ◆ North Beach Storage/Pump Station Upgrade
- ◆ Brandon Separation Project

The revised Denny Way project, the Harbor CSO Pipeline Project and the Henderson/Martin Luther King Jr. Way CSO Control Project form the basis of the CSO Control Program for the next five years. Construction for the North Beach project is scheduled to be complete in 2011, and Brandon project construction is scheduled for completion in 2022 as listed in the Executive's Preferred Plan. The projects are described below.

1.3.2.1 Denny Way/Lake Union CSO Control Project

As discussed in Section 1.3.1.3, the Denny Way/Lake Union CSO control Project was identified in 1994 as a joint project for King County and the City of Seattle. The City completed construction of Phase 1 in 1997; a project to increase wet-weather capacity in the east and south Lake Union areas. The City's Phase 2 project will connect the Phase 1 facilities to the County's Phases 3 and 4 facilities.

Phase 3 and 4 of the project will control Lake Union and Denny Way CSOs by 1) storing CSO flows during moderate storms and transferring them to the West Point treatment plant after the storm subsides; and 2) providing on-site treatment at the Elliott West site with discharge of treated flows through a new outfall during heavy rain conditions. Facilities include:

- ◆ a 6,200 ft. long tunnel under Mercer Street between Dexter Avenue North and Elliott Avenue West (for CSO storage and conveyance)
- ◆ CSO control facilities at the Elliott West site (with floatable removal, disinfection, and dechlorination)
- ◆ piping and regulators to convey CSO flows from the existing County sewer system to the new facilities
- ◆ an outfall into Elliott Bay at Myrtle Edwards Park (to discharge treated flows from the Elliott West facilities)
- ◆ an extension of the existing outfall at the Denny regulator at Myrtle Edwards Park (to discharge untreated CSO flows, expected to occur about once per year)

A general milestone schedule for project implementation is shown below:

- | | |
|--|-------------|
| ◆ Preliminary Design Began | Spring 1997 |
| ◆ Facilities Plan Submitted to Ecology | Spring 1998 |
| ◆ Final Design Begins | Fall 1998 |
| ◆ Construction Begins | 2000 |
| ◆ Construction Complete | 2003 |

A joint final State Environmental Policy Act (SEPA) Environmental Impact Statement (EIS)/National Environmental Policy Act (NEPA) Environmental Assessment for Phases 2 and 3/4 was issued in July 1998. Construction of the City and County projects is scheduled to be completed by the end of 2003.

1.3.2.2 Harbor CSO Pipeline Project

The Harbor CSO Pipeline Project will convey overflows from the Harbor Regulator to the new West Seattle pump station for storage in the new West Seattle Tunnel, controlling CSO events at the Harbor regulator station to one event per year or less. This is a change from the *1988 Plan* which recommended partial separation to control Harbor CSOs. The project was revised when recent County modeling indicated that partial separation would not control Harbor CSOs to the one event per year level, requiring the addition of storage. The availability of nearby storage in the West Seattle Tunnel made the Harbor CSO Pipeline a cost effective alternative.

The current Harbor project was re-prioritized to be completed sooner than scheduled in the *1988 Plan* due to the cost and environmental benefits from constructing the pipeline concurrently with the Alki Project's West Seattle forcemain. The Harbor pipeline portion of the project enlarged the trench for the forcemain and laid a new 54-inch pipe underneath. The cost of the current Harbor project was much less than the cost of excavating a new pipeline and trench for the 54-inch pipe. Risk of affecting the integrity of the forcemain by future construction was also avoided.

The Alki Project's West Seattle Forcemain contract was completed in 1996. CSOs from the Harbor Regulator will be stored in the tunnel beginning in 1999 when the Alki CSO Treatment Plant modifications are complete.

1.3.2.3 Henderson/Martin Luther King Jr. Way CSO Control Project

At the time of adoption of the 1988 Plan, the County believed that all CSOs into Lake Washington, including the discharge from the Henderson Street pump station and Martin Luther King Jr. Way overflow weirs, had been controlled to the one event per year level. However, subsequent monitoring data indicated that overflows occurred more frequently than once per year at these locations.

- As a result, in 1995 the County developed an engineering evaluation of the basin tributary to the Henderson/Martin Luther King Jr. Way CSOs to determine the sources and causes of the overflows at these locations, and identified interim and permanent corrective measures to control overflows. The evaluation also considered the impact of these measures on the downstream Norfolk regulator station. Based on this evaluation, the recommended alternative was to construct a 3.2 MG storage tank/CSO treatment facility near the Norfolk regulator station along with associated conveyance and pumping improvements.

In 1997, King County began predesign work on the Henderson/M.L. King Project. During evaluation of alternatives, it was determined that a storage/treatment tunnel was more cost effective than the storage/treatment tank alternative. In addition, the storage tunnel had a conveyance system benefit, lower O&M, less adverse community impacts and was more consistent with the approach being used on other CSO projects. Therefore, the storage treatment tunnel emerged from predesign as the preferred alternative.

The Project elements and schedule are as follows:

- | | |
|-----------------------------------|------------------------------|
| ◆ Forcemain Contract | June 1999 to June 2000 |
| ◆ Tunnel Overflow Contract | June 1999 to June 2000 |
| ◆ Tunnel Contract | April 1999 to September 2001 |
| ◆ Henderson Pump Station Contract | June 1999 to March 2001 |

1.3.2.4 North Beach Storage/Pump Station Upgrade

King County believed in 1988 that overflows from the North Beach pump station had been controlled to one event per year. However, during predesign for the Carkeek Park CSO treatment plant, overflows exceeding one event per year were identified at North Beach. As a result, the County initiated a predesign effort to control these overflows and a report was completed in July 1993. The report recommended construction of a new storage basin at the pump station site, an increase in pump station capacity, and construction of a new pipeline in Carkeek Park to reroute flows from two City of Seattle gravity sewer lines that discharge directly to the County's forcemain. In the Executive Preferred Plan, this project would be constructed by 2011.

1.3.2.5 Brandon Separation Project

During predesign of the Michigan Separation project, the predesign team recommended the addition of a Brandon partial separation and storage project. Recent County modeling for the *RWSP* indicates that CSO control at Brandon would be best achieved via on-site CSO treatment. The schedule for implementation of a Brandon project is 2022 in the Executive's Preferred Plan.

1.3.3 Other Related Projects

1.3.3.1 King County's Water Quality Assessment

To gain a better understanding of CSO impacts in Elliott Bay and the Duwamish River, King County has completed a CSO water quality assessment (WQA).

The CSO WQA was designed to:

- ◆ Determine existing conditions in Elliott Bay and the Duwamish River by sampling, monitoring, and computer modeling the water column and sediments.
- ◆ Understand the relative significance of CSO pollutants compared to other pollutant sources by studying CSO impacts on human health and aquatic life.

The overall findings of the study are:

- ◆ There is clear evidence of potential risks to aquatic life, wildlife, and people - both under existing conditions and without CSOs.

- The primary source of risks to humans and wildlife from chemicals are due to historically contaminated sediments.
- There are some risks to humans 6 to 24 hrs after a CSO event from pathogens and viruses in the water column.

A stakeholder committee has participated in the development of the analysis and review of the findings, and is expected to provide recommendations to the King County Executive on the future of the CSO control program by the end of 1998.

1.3.3.2 Lander and Densmore Stormwater Management Program

King County and the City of Seattle are jointly undertaking a stormwater management program in the Lander and Densmore drainage basins as required by the NPDES municipal stormwater permit. This is an on-going program which includes the following elements: source control, baseline sampling of stormwater discharges, surveys, inspections, and educational outreach. The maintenance of the stormwater system, the development of compliance schedules and enforcement actions are to be managed by the City of Seattle as specified in an Interlocal Agreement by and between the City of Seattle and King County. Future separation projects such as the Kingdome Separation Project, will add areas to this program.

1.3.3.3 Sediment Baseline Monitoring Plan

A Sediment Baseline Monitoring Plan was submitted to Ecology and approved in August 1995. The Plan provides for monitoring of marine sediments in the vicinity of wastewater treatment plant outfalls and CSOs. Each CSO site is characterized in the Plan according to the status of clean-up activities as follows:

- For five sites, a cleanup study is already underway or contemplated in the near future; therefore, no new baseline sampling is being proposed under the plan.
- For five sites, baseline sampling is complete, and no additional sampling is planned unless requested by Ecology.
- For three sites, cleanup activities are anticipated, and sampling is required to facilitate those activities. As shown on Table 1-3, these sites were initially sampled in 1995, and additional biological and chemical analyses were completed in 1996.
- For three sites, baseline sampling was completed in 1996 (see Table 1-3), and no additional sampling is planned unless requested by Ecology.
- For four sites, baseline sampling was completed in 1997 (see Table 1-3), and no additional sampling is planned unless requested by ecology.
- For 1998, no new sites are proposed for baseline sampling.

Table 1-3. Sediment Baseline Monitoring Plan for CSO Sites

CSO Location	Serial	Date	Sample #	Status of Program
Hanford	W031	06/27/95- 06/29/95	L6393-1 - L6393-11	Permit Requirements Met
Connecticut Street	W029	06/26/95- 06/27/95	L6392-1 - L6392-11	Permit Requirements Met
Chelan Avenue	W036	06/28/95- 06/29/95	L6397-1 - L6397-6	Permit Requirements Met
Magnolia	W006	10/16/96	L9695-1 - L9695-6	Permit Requirements Met
53 rd Avenue SW	W053	10/16/96	L9697-1 - L9697-6	Permit Requirements Met
North Beach	W048	10/15/96	L9696-1 - L9696-6	Permit Requirements Met
SW Alaska Street	W055	10/14/97	L12042-1 L12042-6	Permit Requirements Met
Murray Street	W056	10/14/97- 10/15/97	L12043-1 L12043-6	Permit Requirements Met
Barton Street	W057	10/15/97	L12044-1 L12044-6	Permit Requirements Met
63 rd Street	W054	10/14/97	L12041-1 L12041-6	Permit Requirements Met

Section 2 - 1997/98 CSO Volume and Frequency Summary

2.1 Introduction

The volume and frequency of CSOs at regulator and pump stations in the West Point treatment plant system are monitored by the County's CATAD System. Figure 1-1 at the front of this report shows the location of existing King County and City of Seattle CSO discharges. The area south of the Ship Canal is referred to as the Southern Service Area, and the area north of the Ship Canal is referred to as the Northern Service Area (with the exception of the Montlake regulator station). The County deploys portable flowmeters at the following seven CSO locations not currently monitored by CATAD: South Magnolia, East Ballard (11th Ave. NW), North Beach, Terminal 115, Martin Luther King Jr. Way, Henderson Street, and SW Alaska Street (Beach Drive).

2.2 1997/98 CSO Volumes

The total system overflow volume for the June 1997 through May 1998 reporting period was 643.5 MG compared to a baseline volume of 2,393 MG. This represents a 72% reduction in volume.

As shown on Table 2-1, rainfall measured by County rain gauges at pump and regulator stations for the 1997/98 reporting period averaged 35.23 inches. This is two percent below the average rainfall of 36 inches per year. The rainfall average may be underestimated for a portion of the reporting period due to equipment malfunctions at Henderson and University pump stations. The rain gauge problems were fixed in January and February 1998.

Table 2-1
1997/98 Rainfall at Pump and Regulator Stations
(in inches)

Station	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98	Mar-98	Apr-98	May-98	1997/98 Total
Denny Local	1.94	1.08	1.13	2.39	5.02	3.88	1.96	7.82	3.3	3.04	0.69	1.47	33.72
King Street	2.48	1.35	1.13	1.94	4.49	3.84	1.88	8.21	2.88	2.57	0	0.13	30.9
Chelan Avenue	1.95	1.24	1.22	2.46	5.52	3.7	2.48	9.34	3.74	3.2	0.74	1.35	36.94
Denny Way/Lake Union	2.89	1.26	1.81	3.37	4.72	5.31	1.83	9.31	2.77	1.54	0.37	1.23	36.51
Ballard	2.44	0.83	1.33	3.1	5.59	4.07	2.22	8.36	3.33	3.31	1	1.49	37.07
University	1.72	1.08	1.58	2.97	5.33	3.4	0.99	4.72	2.73	2.71	0.96	2.4	30.59
Hollywood	3.35	1.8	1.55	3.01	4.95	3.78	2.46	7.21	3.11	4.02	1.39	2.72	39.35
Rainier Avenue	2.05	1.48	1	2.96	5.8	4.6	2.75	9.75	4.01	3.57	0.8	1.73	40.5
East Marginal Way	1.62	1.24	0.84	2.41	4.23	3.06	1.92	6.61	2.97	2.49	0.7	1.32	29.41
Henderson	1.59	0.92	0.84	2.47	3.44	1.79	1.39	6.13	3.45	3.19	0.8	1.62	27.63
East Pine Street	2.13	1.46	1.2	2.47	4.15	4.05	2.42	9.08	3.71	3.67	0.72	2.75	37.81
Matthews Park	2.47	0.98	1.03	2.66	5.24	4.03	2.38	8.04	3.49	3.08	1.32	2.36	37.08
Kenmore	3.21	1.46	1.6	3.52	5.06	3.87	2.54	8.07	3.56	3.43	1.58	2.61	40.51
Average	2.30	1.24	1.25	2.75	4.89	3.80	2.09	7.90	3.31	3.06	0.85	1.78	35.23

- ◆ Level sensors at the Harbor regulator station do not appear to be working properly due to construction activities associated with the Harbor CSO connection for the West Seattle pump station, and overflow volume at this site may be underestimated. The level sensors will be checked in 1998.
- ◆ When the Hanford #1 separation project was completed in 1987, it was thought that all CSO overflows were eliminated from Hanford #1. However, new monitoring data indicates that CSO events are occurring at the site and these estimated volumes and frequencies are reported in Tables 2-2 and 2-3. The discharge location for Hanford #1 CSOs is the Diagonal storm drain discharge.

2.2.2 Northern Service Area (NSA)

Overflow volumes in the Northern Service Area for 1997/98 were 106 MG compared to a baseline of 353 MG. While there was less overall rain, when it hit, it hit hard, resulting in substantial overflow volumes at the following NSA stations: Dexter, Montlake, Belvoir, and North Beach.

- ◆ Dexter overflowed 25 MG compared to a baseline of 15 MG. The higher volume at Dexter continues to be investigated. The CATAD overflow calculation may be resulting in inflated overflow volumes and will be checked this year.

2.2.3 Carkeek Park CSO Plant

See Carkeek Annual Report.

2.2.4 1997/98 CSO Volumes Compared to Previous Years

Figure 2-2 illustrates the progress King County has made in CSO control; the baseline volumes are illustrated by the first column with yearly measurements in the subsequent columns. During the 1989/90 and 1990/91 reporting periods, a number of CSO control projects were still under construction and benefits had not yet been realized. Below average rainfall during the 1991/92, 1992/93, and 1993/94 reporting periods resulted in decreased overflow volumes. Average rainfall returned during the 1994/95 reporting period and higher than average rainfall occurred in 1995/96 and 1996/97; however, 1997/98 overflow volumes continue to remain below baseline overflow volumes. Thus, benefits from completed CSO control projects are now being consistently observed.

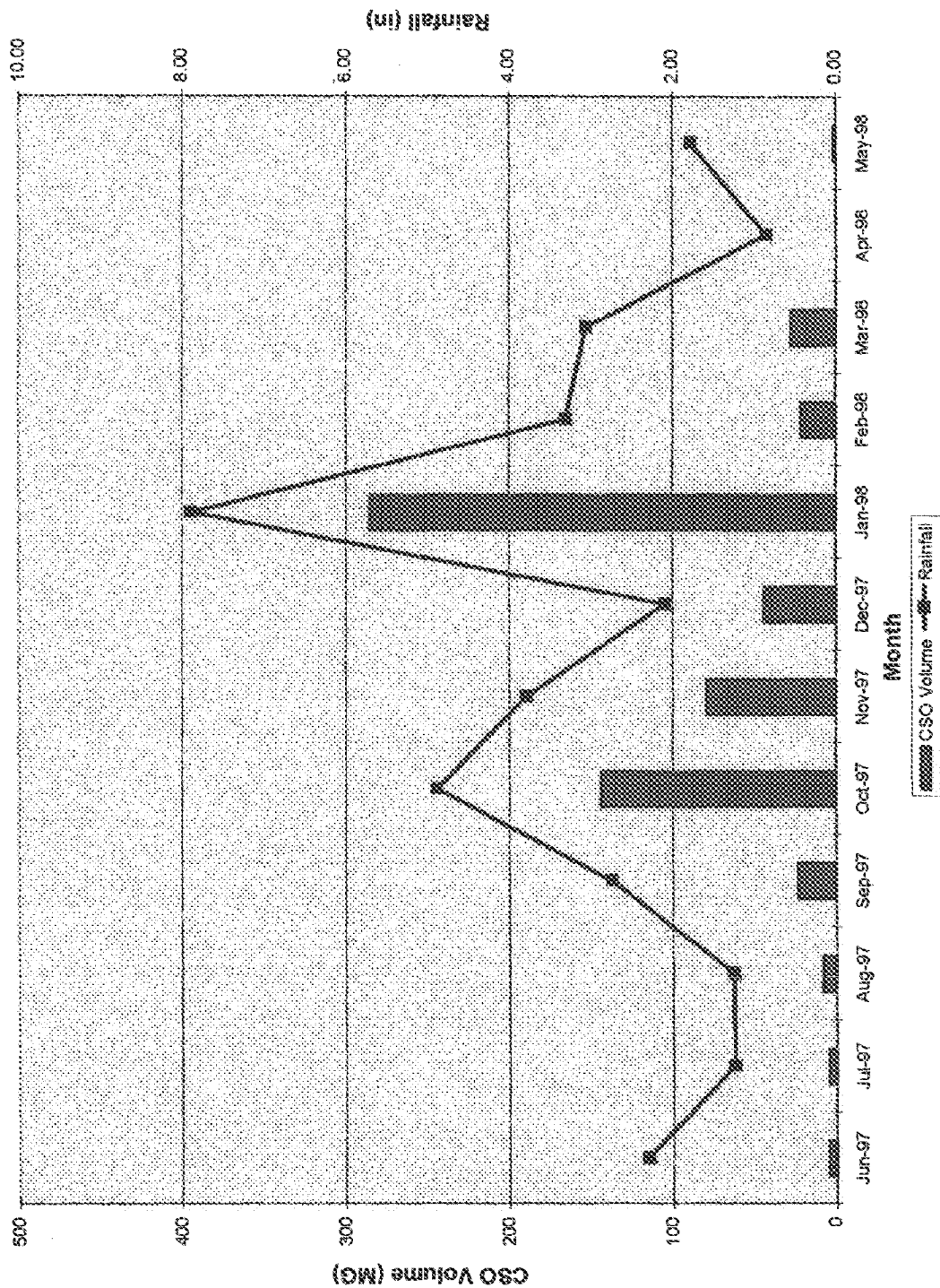
Table 2-2
1997/98 CSO Volume Summary by Service Area
(in million gallons)

Station	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98	Mar-98	Apr-98	May-98	1997/98 Total (MG)	Revised Baseline (2) (MG)
SSA														
Denny Way	2.5	2.5	1.6	8.1	65.9	32.8	16.4	120.4	14.4	15.1	0.0	0.0	299.9	405
King Street	0.0	0.0	0.0	0.7	2.7	1.4	1.3	10.9	0.0	0.2	0.0	0.0	17.2	55
Connecticut	0.0	0.0	0.0	0.0	2.4	0.0	0.2	11.6	0.0	0.0	0.0	0.0	14.2	90
Hanford	0.7	0.0	0.0	0.4	13.5	8.1	12.3	42.7	0.5	0.7	0.0	0.0	78.9	605
Lander II St.	0.0	0.0	0.0	0.0	0.0	0.7	2.2	18.8	0.0	0.0	0.0	0.0	21.7	190
Harbor Ave.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55
Chelan	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.3	65
W. Michigan	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.3	2
8th Ave.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13
Brandon St.	0.8	1.4	0.3	4.2	11.9	4.9	10.1	35.4	6.1	0.5	0.1	0.0	75.6	60
Michigan St.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	190
Norfolk St.	0.0	0.0	0.1	0.7	0.2	6.7	0.0	5.4	0.0	1.6	0.0	0.0	14.8	70
Durham St. S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11
Henderson (1)	0.0	0.0	0.0	0.2	1.0	0.0	0.1	0.9	0.0	0.0	0.0	0.0	2.2	10
M.L.K. Jr. Way (1)	0.0	0.5	0.0	2.3	5.6	0.1	1.5	2.4	0.0	0.0	0.0	0.0	12.3	88
Rainier Ave.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
E. Marginal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
W. Marginal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
S. Magnolia (1)	0.1	0.0	0.6	1.0	0.0	0.8	0.0	1.1	0.0	0.5	0.0	0.0	4.0	13
Terminal 115													N/A	5
SSA SUBTOTAL	4.0	4.4	2.6	22.1	112.0	58.4	44.2	249.7	21.0	18.6	0.1	0.0	537.2	1921
NSA														
Balford	0.0	0.0	0.1	0.2	9.9	1.7	0.0	1.5	0.0	1.9	0.0	0.0	13.5	90
Dexter	0.1	0.2	5.6	0.6	5.1	10.3	0.0	0.5	0.0	2.9	0.0	0.0	25.3	15
University	0.1	0.0	0.0	0.0	8.9	8.0	0.0	24.2	0.0	2.3	0.0	0.0	33.5	110
Montlake	0.0	0.0	0.0	0.0	5.3	0.0	0.0	6.8	0.0	0.8	0.0	1.7	14.6	10
Canal St. (Lake City)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2	11
Third Ave. W.	0.0	0.0	0.0	0.0	0.8	0.4	0.0	1.8	0.0	0.0	0.0	0.0	2.9	125
E. Pine St.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Belvoir	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0
Matthews Park	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
30th Ave. NE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
North Beach (1)	0.0	0.0	0.0	0.2	1.8	0.5	0.0	0.9	0.0	0.0	0.0	0.0	3.4	2
NSA SUBTOTAL	0.2	0.2	5.6	0.9	31.8	21.0	0.0	35.9	0.0	2.9	0.0	1.7	106.5	253
CARKEEK														
Carkeek CSO Plant													See Carkeek Annual Report	
ALKI														
Murray														5
Barton													N/A	7
33rd Ave. SW														51
SW Alaska St. (Beach Dr.) (1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12
33rd Ave.														05
TOTAL	4.2	4.7	8.3	23.0	143.8	79.4	44.2	285.6	21.0	21.5	0.1	1.8	643.7	2173

(1) Portable flow meters; not currently monitored by CATAD.

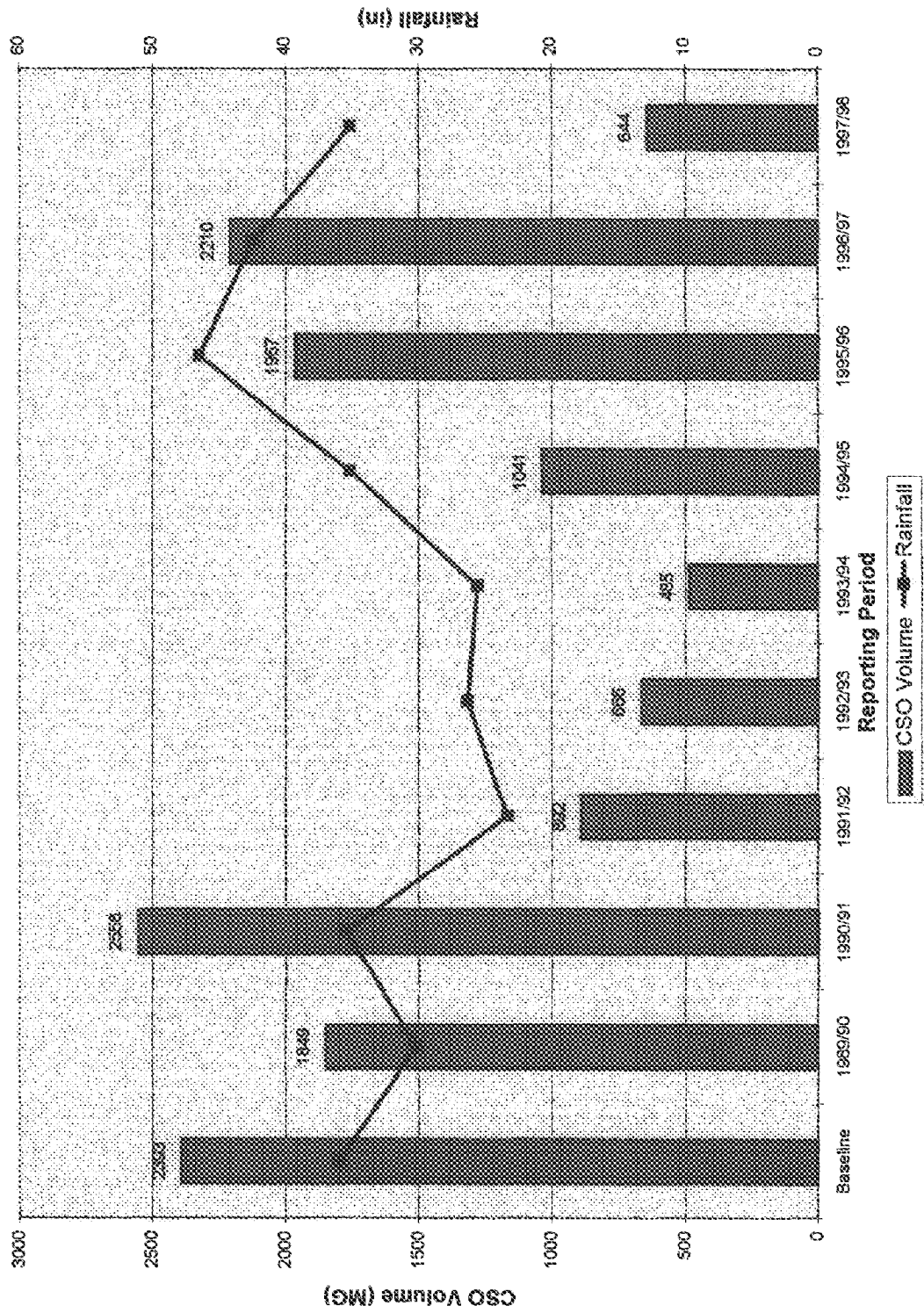
(2) Baseline for both CSO frequency and volumes have been revised since the 1988 final CSO Plan due to improvements made to the computer modeling system that provided more accurate projections on historical and future conditions.

Figure 2-1. 1997/98 CSO Volume vs. Rainfall



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Figure 2-2. Annual CSO Volumes



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2.4 1997/98 CSO Frequency of Events

In the 1988 plan, the County defined an overflow event as a period of time during which an overflow was recorded that was preceded by three hours with no rain and followed by three hours without overflows system-wide. Thus, each event is separated by at least three-hours of non-discharge.

During the 1997/98 reporting period, 351 overflow events were recorded compared to a baseline of 599 events as shown in Table 2-3. Figure 2-3 graphically illustrates the relationship between rainfall and overflow events for the reporting period. To date, the County has controlled the following CSO locations to one event per year: E. Pine St., Belvoir, Matthews Park, Rainier Ave., E. Marginal, 30th Ave. NE, Duwamish pump station, Canal St., and 53rd Avenue SW.

King County is currently evaluating the event definition to determine if the current three hour definition is appropriate based on historical rainfall record for the area. In reporting CSO events, a single independent rainfall event should produce only one CSO event. The three-hour period of non-discharge is being examined to determine if rainfall patterns in the King County service area may require a longer period of non-discharge to define independent events.

The current event modeling effort is comparing overflows for a three hour inter-event period and a 48 hour inter-event period. The 48-hour period of non-discharge was chosen since it is used to characterize discharge events at Carkeek and appears to better represent the duration intervals between independent rainfall events that result in CSOs. The model is being run for both event periods using the years of mid-1978 to mid-1987 and mid-1994 to mid 1996 for simulation. These time periods were selected because the average annual rainfall over these periods is the same as the 36 inches annual average from historical data. The 1996 conditions are without the Alki Transfer and with the Norfolk Diversion.

The early modeling results show a significant decrease in number of annual average CSO events using the 48 hour rather than 3 hour inter-event period. The model is being refined and requires verification before the results are reported. However, a comparison of the 3 hour and 48 hour inter-event periods will be included in the 1998/99 Annual CSO Report and the 2000 5-Year Update. CSO projects are designed to accommodate peak flows associated with the one-year storm; therefore, re-defining the event interval is not expected to appreciably affect the scale and cost of CSO capital projects.

For comparison purposes, the 1997/98 CSO frequency of events were re-calculated based on a 48-hour period of non-discharge for the measured data during the reporting period. This resulted in 246 events during the reporting period (see Table 2-4 and Figure 2-4), a significant decrease from the 351 events calculated with the 3 hour inter-event period. This significant decrease suggests that many of the overflow events occur within a few hours of each other; thus, a single independent rainfall event may be resulting in more than one CSO event when the 3 hour inter-event definition is used.

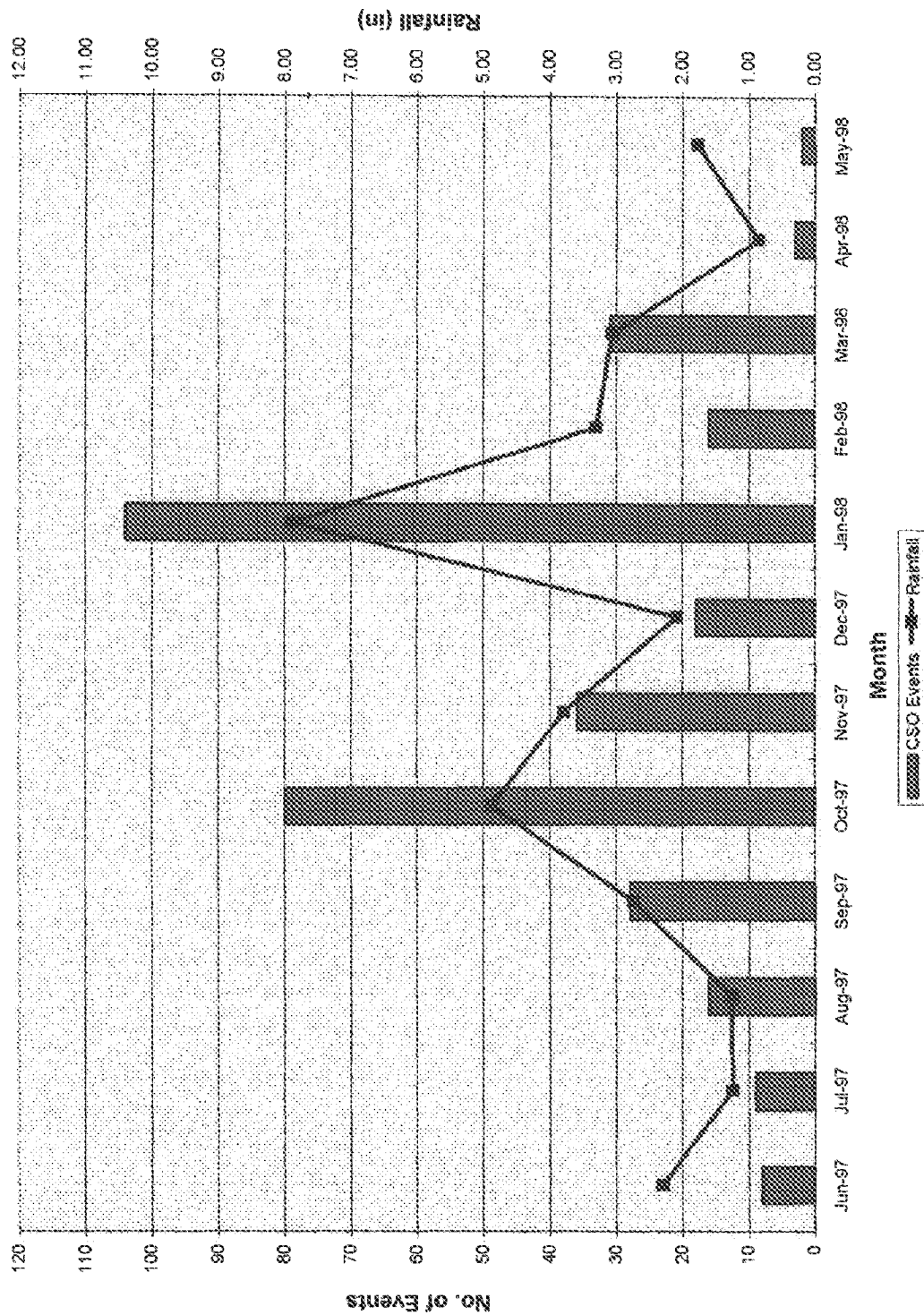
Table 2-3
1997/98 Frequency of CSO Events
 (Based on 3 hour non-discharge definition)

Station	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98	Mar-98	Apr-98	May-98	1997/98 Total	Revised Baseline
													(overflows/yr.)	
SSA														
Denny Way	1	1	3	4	6	4	1	10	3	4	0	0	37	51
King Street	0	0	1	1	6	1	1	6	1	1	0	0	17	31
Connecticut	0	0	0	0	1	0	1	4	0	0	0	0	5	34
Hanford #1 (@Rainier) (1)	0	0	0	0	5	1	2	9	1	1	0	0	19	
Hanford #2	1	0	0	1	4	2	1	6	1	1	0	0	17	40
Lander II St.	0	0	0	1	4	3	1	6	0	0	0	0	15	29
Harbor Ave.	0	0	0	0	0	0	0	0	0	0	1	0	1	56
Chelan	0	0	0	0	2	0	0	1	0	0	0	0	3	25
W. Michigan	0	0	0	1	2	0	0	1	0	0	0	0	4	9
8th Ave.	0	0	0	0	0	0	0	0	0	0	0	0	0	12
Brandon St.	1	2	2	4	8	5	5	9	4	3	1	1	49	40
Michigan St.	0	0	0	0	0	0	0	0	0	0	0	0	0	40
Norfolk St.	0	0	2	3	1	2	0	4	0	3	0	0	16	12
Duwamish P.S.	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Henderson (1)	0	0	0	1	3	0	1	5	1	1	0	0	12	16
MLK Jr. Way (1)	0	2	0	1	6	1	1	7	1	2	0	0	17	23
Rainier Ave.	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
E. Marginal	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
W. Marginal	0	0	0	0	0	0	0	0	0	0	0	0	0	
S. Magnolia (1)	3	1	3	6	1	5	1	6	3	3	1	0	33	21
Terminal 113													N/A	8
SSA SUBTOTAL	6	8	11	23	52	24	15	74	15	19	3	1	246	447
NSA														
Ballard	0	0	0	0	5	0	0	2	0	1	0	0	8	13
E. Ballard (11th Ave. NW) (1)	0	1	2	3	6	4	0	4	1	3	0	0	24	13
Dexter	1	1	3	1	6	2	1	4	0	4	0	0	22	4
University	1	0	0	0	2	1	0	2	0	1	0	0	5	14
Montlake	0	0	0	0	3	0	0	3	0	2	0	1	9	16
Canal St. (Lake City)	0	0	0	0	0	0	0	2	0	0	0	0	2	<1
Third Ave. W.	0	0	0	0	2	1	0	4	0	0	0	0	5	20
E. Pine St.	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Belvoir	0	0	0	0	0	1	0	0	0	0	0	0	1	<1
Matthews Park	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
30th Ave. NE	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
North Beach (1)	0	1	0	1	7	3	2	9	0	1	0	0	24	18
NSA SUBTOTAL	2	3	5	5	31	12	3	30	1	12	0	1	105	98
CARKEEK														
Carkeek CSO Plant													See Carkeek Annual Report	
ALKI														
Murray													N/A	8
Barton													N/A	23
53rd Ave. SW													N/A	<1
SW Alaska St. (Beach Dr.) (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	23
63rd Ave.													N/A	N/A
TOTAL	9	9	16	29	80	35	18	98	16	31	3	3	351	599

(1) Portable flow meters; not currently monitored by CATAD.

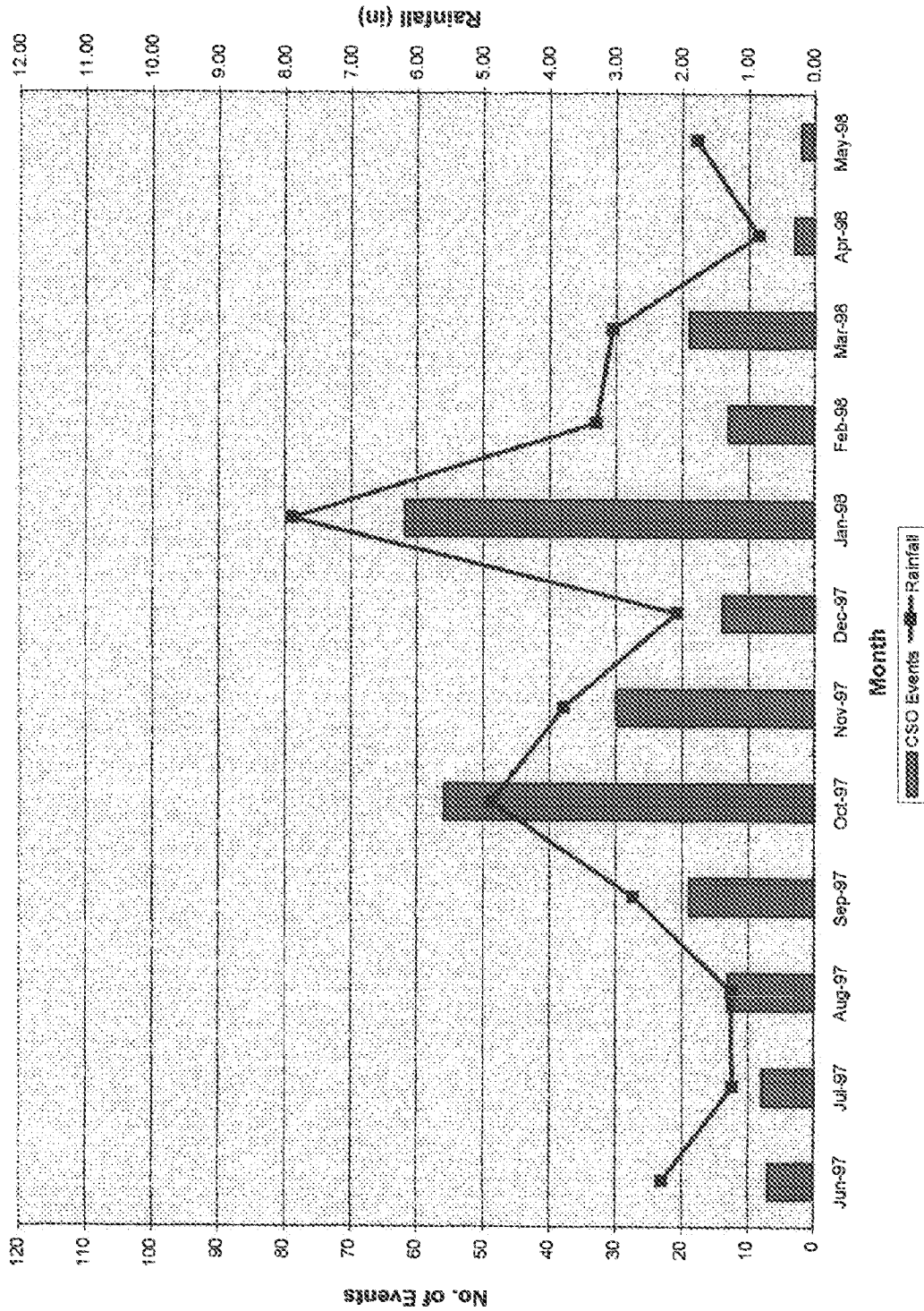
(2) Baseline for both CSO frequency and volumes have been revised since the 1988 Final CSO Plan due to improvements made to the computer modeling system that provided more accurate projections on historical and future conditions.

Figure 2-3. 1997/98 CSO Events (Based on 3 hr non-discharge) vs. Rainfall



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Figure 2-4. 1997/98 CSO Events (Based on 48 hr non-discharge) vs. Rainfall



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Table 2-4
1997/98 Frequency of CSO Events
 (Based on 48 hour non-discharge definition)

Station	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98	Mar-98	Apr-98	May-98	1997/98 Total (overflows/yr.)
SSA													
Denny Way	1	1	2	1	3	3	2	4	2	1	0	0	20
King Street	0	0	1	1	3	1	1	4	1	1	0	0	12
Connecticut	0	0	0	0	1	0	1	4	0	0	0	0	5
Hanford #1 (@ Rainier) (1)	0	0	0	1	4	1	1	4	1	1	0	0	13
Hanford #2	1	0	0	1	2	2	1	3	1	1	0	0	12
Lander II St.	0	0	0	0	1	3	2	1	3	0	0	0	10
Harbor Ave.	0	0	0	0	0	0	0	0	0	0	1	0	1
Chelan	0	0	0	0	2	0	0	1	0	0	0	0	3
W. Michigan	0	0	0	1	2	0	0	1	0	0	0	0	4
8th Ave.	0	0	0	0	0	0	0	0	0	0	0	0	0
Brandon St.	1	1	2	2	8	3	2	4	3	2	1	1	27
Michigan St.	0	0	0	0	0	0	0	0	0	0	0	0	0
Norfolk St.	0	0	2	3	1	2	0	2	0	3	0	0	14
Duwamish P.S.	0	0	0	0	0	0	0	0	0	0	0	0	0
Henderson (1)	0	0	0	1	2	0	1	3	1	1	0	0	9
MLK Jr. Way (1)	0	2	0	1	4	1	1	7	1	1	0	0	16
Rainier Ave.	0	0	0	0	0	0	0	0	0	0	0	0	0
E. Marginal	0	0	0	0	0	0	0	0	0	0	0	0	0
W. Marginal	0	0	0	0	0	0	0	0	0	0	0	0	0
S. Magnolia (1)	2	1	2	2	1	3	1	3	2	2	1	0	20
Terminal 115													N/A
SSA SUBTOTAL	5	5	9	15	36	18	12	43	12	13	3	1	172
NSA													
Ballard	0	0	0	0	5	1	0	1	0	1	0	0	7
E. Ballard (11th Ave. NW) (1)	0	1	2	3	3	3	0	1	1	1	0	0	15
Dexter	1	1	2	0	3	2	1	3	0	1	0	0	14
University	1	0	0	0	2	1	0	2	0	1	0	0	7
Montlake	0	0	0	0	1	0	0	2	0	1	0	1	5
Canal St. (Lake City)	0	0	0	0	0	0	0	2	0	0	0	0	2
Third Ave. W.	0	0	0	0	2	1	0	3	0	0	0	0	6
E. Pine St.	0	0	0	0	0	0	0	0	0	0	0	0	0
Belvoir	0	0	0	0	0	1	0	0	0	0	0	0	2
Matthews Park	0	0	0	0	0	0	0	0	0	0	0	0	0
30th Ave. NE	0	0	0	0	0	0	0	0	0	0	0	0	0
North Beach (1)	0	1	0	1	4	3	1	5	0	1	0	0	16
NSA SUBTOTAL	2	2	3	4	20	12	2	19	1	6	0	1	74
CARKEEK													
Carkeek CSO Plant													See Carkeek Annual Report
ALKI													
Murray													N/A
Barton													N/A
53rd Ave. SW													N/A
SW Alaska St. (Beach Dr.) (1)	0	0	0	0	0	0	0	0	0	0	0	0	0
63rd Ave.													N/A
TOTAL	8	8	13	20	51	18	14	39	13	16	3	1	207

(1) Portable flow meters; not currently monitored by CATAD.

Section 3 - CSO Monitoring Program

King County's CSO monitoring program includes discharge and sediment sampling of selected CSO sites to meet the requirements of WAC 173-245-040 and conditions in NPDES Permit WA-002918-1. As described in the *1988 Plan*, the County's sampling program was to collect data for five CSO sites per year. Discharge samples were to be taken four times per year under overflow conditions to characterize the CSO effluent at each site. Discharge monitoring requirements were completed in 1995 as shown in Table 3-1.

The *1988 Plan* also provided for sediment samples to be taken at nine CSO sites. These requirements were completed in 1990 as shown in Table 3-2. However, the County has developed a comprehensive, site-specific baseline study plan for chemical and biological analysis of the sediment to meet additional NPDES requirements. Refer to the first section of this report for a description of this Sediment Baseline Monitoring Plan.

Table 3-1. CSO Discharge Monitoring Program

CSO Location	Serial	Date	Sample #	Status of Program
Michigan Street	W039	03/26/88	8800300	Permit Requirements Met
Lander Street	W030	03/26/88	8800301	Permit Requirements Met
Denny Way	W027	03/25/88	8800302	Permit Requirements Met
11th Ave. NW (E. Ballard)	W004	02/22/89 04/06/88 01/14/88 11/02/88	8801743 8800352 8800052 8802026	Permit Requirements Met
3rd Avenue West (& Ewing Street)	W008	02/22/89 01/14/88 03/26/88 11/02/89	8801742 8800053 8800303 8802027	Permit Requirements Met
Ballard	W003	12/02/89 03/09/90 10/04/90 01/06/90	8909776 9000286 9000880 9000002	Permit Requirements Met
Connecticut Street	W029	08/22/89 10/22/89 04/23/90 02/07/90	8900832 8909689 9000394 9000215	Permit Requirements Met
Brandon Street	W041	03/14/90 06/03/90 10/04/90 12/04/90	9000289 9000510 9000881 9010003	Permit Requirements Met
Norfolk Street	W044	10/14/90 06/06/90 04/03/91 12/04/90	9000887 9000524 9100612 9010006	Permit Requirements Met
W. Michigan Street	W042	01/12/91 04/03/91 01/28/92 10/06/93	9100012 9100613 9200134 L2224-1	Permit Requirements Met
8th Avenue	W040	12/27/94	L5152-1	Further Monitoring Not Required
Chelan Avenue	W036	10/26/94 11/30/94 01/31/95	L4817-1 L5032-1 L5357-1	Further Monitoring Not Required
Dexter Avenue	W009	12/19/94 02/18/95	L5122-1 L5494-1	Further Monitoring Not Required
Montlake	W014	12/04/90 04/03/91 02/21/92 03/23/95	9100009 9010609 9010006 L5766-1	Permit Requirements Met

Table 3-2. CSO Sediment Monitoring Program

CSO Location	Serial	Date	Sample #	Status of Program
Ballard	W003	05/30/89	8900560	Permit Requirements Met
11th Ave. NW (E. Ballard)	W004	05/30/89	8900561	Permit Requirements Met
3rd Ave. W. (& Ewing St.)	W008	05/30/89	8900563	Permit Requirements Met
Dexter Avenue	W009	05/30/89	8900565	Permit Requirements Met
Montlake	W014	05/30/89	8900564	Permit Requirements Met
8th Avenue	W040	05/23/90	9006690	Permit Requirements Met
Brandon Street	W041	05/23/90	9006687	Permit Requirements Met
Michigan Street	W042	05/23/90	9006691	Permit Requirements Met
Norfolk Street	W044	05/23/90	9006688	Permit Requirements Met

*1997/98 ANNUAL
COMBINED SEWER OVERFLOW
REPORT*

*King County Department of Natural Resources
Wastewater Treatment Division*

October 1998



KING COUNTY
Department of Natural Resources

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